Review and Assessment of

IT Corporation's
Results of Soil Vapor Assessment at the SeaWorld Expansion Plan, 16-Acre Tract

and

SWAPE LLC's
Hydrogen Sulfide and Methane at Mission Bay Landfill

Prepared for

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Date

Introduction

A comprehensive review and assessment was conducted for the following documents: 1) *Results of Soil Vapor Assessment, SeaWorld Expansion Plan, 16 Acre Tract (IT 2002)* and 2) Memorandum: *Hydrogen sulfide and methane at Mission Bay Landfill (SWAPE LLC 2003).* The evaluation focused specifically on the human health impact of Mission Bay Landfill-associated gases on the proposed development, "Journey to Atlantis" amusement ride and SWAPE LLC's assessment of human health risk based on the Soil Vapor assessment conducted by IT in 2002. Supporting documents consulted included: *Letter to Mr. John Wilks III, Sierra Club (Department of Toxic Substances Control 2003), Letter to Ellen Lirley, California Coastal Commission (Anheuser-Busch 2003), Demonstration of Compliance with Title 27, Section 21190, for the "Journey to Atlantis" Amusement Ride (URS 2003)*, and *Letter to Mr. Peter Douglas, California Coastal Commission (Handman 2003).*

The Journey to Atlantis amusement attraction is currently in the process of construction within 1000 feet from the adjacent closed Mission Bay South Shores Landfill. The development area encompasses approximately 5 acres and is located just south of the Wild Arctic Exhibit at the SeaWorld Entertainment Park in the Mission Bay area of San Diego, California. The landfill operated between 1952 and 1959 and was used for the disposal of municipal and industrial wastes. Proposed development activities for the "Journey to Atlantis" ride are at least 500 feet from the landfill footprint and are discussed in detail in *Demonstration of Compliance with Title 27 Section 21190, for the "Journey to Atlantis" Amusement Ride (URS 2003).*

Results of Soil Vapor Assessment, SeaWorld Expansion Plan, 16 Acre Tract (IT 2002)

In October 2001, SeaWorld directed the installation of temporary soil vapor probes at 28 locations within its current property, including the area proposed for the development of the "Journey to Atlantis" amusement ride. Soil vapor probes were spaced on a grid basis at approximately 100 foot intervals. Soil vapor was collected at depths of 5 and 15 feet below ground surface (bgs) at each location. At locations where groundwater was encountered above 15 feet, the deep probe was installed at 10 or 12 feet bgs or no soil vapor probe was installed. No borings were advanced below the water table. Analytical results indicated elevated methane and hydrogen sulfide concentrations at one of the sampling locations (i.e. 1820 parts per million by volume (ppmv) hydrogen sulfide at sample location J-24, approximately 540 feet from the boundary of the proposed ride location). Elevated concentrations were not detected on the footprint of the proposed amusement ride. Field methane concentrations greater than 0.5% by volume were not found greater than 400 feet from the landfill (0.5% is 10 times the lower than the lower explosive limit of methane which is 5% by volume). The field measurement data strongly suggests that as distance from the landfill increases, concentrations of methane in soil vapor significantly decreases.

Five laboratory analytical samples were also collected at various locations on the SeaWorld 16 acre tract development property. One of these samples (sample point J-2)

was located in the vicinity of the proposed ride location. Methane concentrations in the proposed development area were below 0.5% by volume. Hydrogen sulfide was not detected above laboratory reporting limits. The foregoing data indicates that there is no reasonable likelihood of a risk to human health based on such gas concentration levels.

SWAPE LLC Review

Dr. Rosenfeld makes several inaccurate, irrelevant or false claims in his position paper to the California Earth Corps.

Inaccurate, Irrelevant or False Claim 1: Dr. Rosenfeld claims that he has reviewed the material related to soil vapor gases on the SeaWorld 16 acre development property. Following his review, Dr. Rosenfeld submits that high methane and hydrogen sulfide concentrations in subsurface soils pose a threat to human health and the environment. Specifically, Dr. Rosenfeld claims that the proposed ride "Voyage to Atlantis" will be located very close to extremely high concentrations of hydrogen sulfide and methane that pose an immediate high risk to human health and the environment.

Response to Claim 1: It is difficult to understand Dr. Rosenfeld's claim that high methane and hydrogen sulfide concentrations in subsurface soils (approximately 540 feet away from the nearest potential human receptor) pose an immediate and high health risk at the "Journey to Atlantis" ride location. Review of IT Corporation's soil vapor study indicates that methane was not detected at concentrations greater than 0.5% by volume within 400 feet from the landfill. As Dr. Rosenfeld has accurately stated, the lower explosive limit (LEL) of methane is 5% by volume. Thus methane concentrations at all locations 400 feet from the landfill are at least 10 times lower than the LEL. Of greater importance however is the fact that measurements in the field were unable to detect methane at concentrations greater than 0.3% at any of the 13 soil vapor probes located on the proposed area of the "Journey to Atlantis" footprint (i.e. all samples were nondetect on the footprint of the proposed development site). Laboratory analytical results substantiate the field test results. Methane was not detected at concentrations greater than 0.5% on the development footprint (methane detected at sample location J-2 was 0.43%). Hydrogen sulfide was also not detected in the area of the proposed ride location (<0.3% by volume). Confirmation air sampling by the Department of Toxic Substances Control (DTSC) in the immediate vicinity of the highest methane and hydrogen sulfide concentrations (Sample J-24) was also unable to detect these chemicals above laboratory detection limits. The data therefore suggest no reasonable likelihood of a risk to human health at the" Journey to Atlantis" ride's current location. The DTSC data suggest that even if the ride were built directly over the highest hydrogen sulfide concentration area (directly adjacent to the landfill), risks to people on the ground surface would be negligible. Thus it can only be expected that risks to people on the ground surface over 540 feet away from this location would surely be lower. Dr. Rosenfeld's accusation of immediate and high risk at the "Journey to Atlantis" ride do not have scientific basis and should be dismissed as erroneous.

Inaccurate, Irrelevant or False Claim 2: Dr. Rosenfeld compares levels of hydrogen sulfide and methane found at location LE-4 and hydrogen sulfide concentrations at location J-24 to regulatory exposure limits and suggests that levels found at the site may result in adverse health effects at the "Journey to Atlantis" amusement ride.

Response to Claim 2: Dr. Rosenfeld makes inaccurate references to regulatory exposure limits. Soil vapor data collect by IT Corporation does not support his claim. Data on the footprint of the proposed site suggest negligible concentrations of both methane and hydrogen sulfide. Methane and hydrogen sulfide are extremely common occurrences in former estuary type environments and detections of these compounds are likely not due to landfill gas migration, but rather natural and significant decomposition of organic vegetative material. His comparison of concentrations found at locations LE-4 and J-24 to the National Institute of Occupational Safety and Health (NIOSH) permissible exposure limits (PELs) and the Office of Environmental Health Hazard Assessment (OEHHA) reference exposure levels (RELs) are therefore irrelevant. Locations LE-4 and J-24 are approximately 700 and 540 feet, respectively, from the border of the proposed ride footprint. The practice of risk assessment requires that a receptor must have exposure to a toxicant for a risk to be present. In this case there is no exposure as is evident from both the IT ambient air monitoring data and the DTSC confirmation data. Dr. Rosenfeld does not provide any data to suggest that concentrations found 540 feet from the landfill could impact human receptors on the site. Dr. Rosenfeld cannot refute the fact that the concentrations that are relevant (onsite concentrations) are all below regulatory health criteria.

Inaccurate, Irrelevant or False Claim 3: Dr. Rosenfeld claims, "all that separates the public from this harmful gas (hydrogen sulfide) is a layer of asphalt, which may be breached of the landfill settlement, liquifaction and/or an earthquake." He goes on to state that " earthquakes will result in significant settling that will likely cause preferential pathways for release of hydrogen sulfide in the air, threatening the public and environment".

Response to Claim 3: Dr. Rosenfeld's comment assumes that landfill gases are *contained* by and accumulate due to asphalt and fill layers on site. However, the asphalt and fill layers that he refers to do not *contain* methane nor do they *contain* hydrogen sulfide gases. As Dr. Rosenfeld's comment indicates, the asphalt is cracked and will continue to crack. Consequently there can be no large amounts of gas accumulation. Cracks in asphalt would result in the opposite of what Dr. Rosenfeld suggests would occur. Even if the asphalt were not cracked and in pristine condition, slow diffusion of subsurface gases would still occur. Asphalt by its very nature is porous. Thus, as is supported by the data collected on site, there is no accumulation of gases beneath an impermeable layer nor is it evident that there is a substantial lateral migration of gases. If a protective and impermeable layer was placed over the site, this barrier could possibly result in the accumulation of gases and be could potentially be breached. However gas vents would obviously be required in this type of situation given the natural formation of methane and hydrogen sulfide during organic decomposition in these types of soils (see below for further discussion). With mitigation efforts in place, gases would not be allowed to

accumulate and there would be no potential for a high concentration of gas to be instantaneously released during a seismic event.

Conclusions

Based on the foregoing data and my document review, it is my opinion that there is no reasonable likelihood that any danger to human health exists to employees who may work at the proposed ride site or to visitors who may frequent the ride location. Soil vapor data collected by IT indicate that landfill associated gases in soil vapor quickly dissipates as you move away from the landfill. At the border of the proposed ride location (approximately 540 feet from the isolated "hit" of concern) methane and hydrogen sulfide were not detected in soil vapor at concentrations that could potentially result in any health risk.

To further support the conclusion stated above, and to address the specific Sierra Club concern that "there is a high likelihood of immediate danger to the public in the immediate vicinity of the SeaWorld Construction site", the DTSC conducted it own investigation of ambient air in the vicinity of Sample location J-24. Five air samples were collected in the breathing zone of the suspect area and evaluated for hydrogen sulfide and methane. Hydrogen sulfide was not detected at any location above its reported laboratory detection limits of 0.034 ppmv. The OEHHA reference exposure level of hydrogen sulfide (acute) is 0.03 ppmv. The reference exposure limit is an OEHHA risk assessment guideline. Exposures less than the limit pose no significant health risk for exposures of 1 hour, for acute limits. Methane was also not detected above its reporting limit of 0.001% weight to volume (w/v). These results strongly support the conclusion that even if the "Journey to Atlantis" ride was constructed in the immediate vicinity of sample location J-24 (over 540 feet away from the boundary of the proposed ride location) there is no reasonable likelihood that health risks from hydrogen sulfide and methane would be present for employees tending the amusement park ride or for visitors who may frequent the ride. Surely, risks to receptors at the actual location of the proposed ride would be substantially less, and, there is no reasonable likelihood that landfill gas will migrate to the Journey to Atlantis site or create a public health risk.

References

Anheuser-Busch, Inc. (2003). Letter to Ellen Lirley, California Coastal Commission.

Department of Toxic Substances Control (2003). Letter to Mr. John Wilks III, Sierra Club.

Handman, Michael (2003). Letter to Mr. Peter Douglas, California Coastal Commission.

IT Corporation (2003). Results of Soil Vapor Assessment, SeaWorld Expansion Plan, 16 Acre Tract.

SWAPE LLC (2003). Memorandum: Hydrogen Sulfide and Methane at Mission Bay Landfill.

URS (2003). Demonstration of Compliance with Title 27 Section 21190, for the "Journey to Atlantis" Amusement Ride.